Goals & Objectives for a 5-yr

BEEF EFFICIENCY · RESEARCH · EDUCATION · EXTENSION

www.BeefEfficiency.org

Background

- Beef production is 4th largest US manufacturing industry with a $71b retail equivalent value in 2006 (www.ers.usda.gov)
  - Genetic improvement of 1% would contribute $0.7b annually to the US economy
- Yearling weight genetic merit has 0.5% pa to increase 120 lb from 1985-2007
  - Contributed to improved efficiency by dilution of maintenance but has probably not changed net efficiency

Dilution of Maintenance

- Suppose 700 units of feed in a cow-calf system produce a weanling
- And 300 units of feed in the feedlot system finish it to 1,000 lb

$$Efficiency = \frac{output}{input} = \frac{1000}{700 + 300} = 1.0$$

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$$Efficiency = \frac{output}{input} = \frac{1000}{700 + 300} = 1.0$$

- Suppose the feedlot finishes to a heavier weight
- And 600 units of feed in the feedlot system finish it to 1,400 lb

$$Efficiency = \frac{output}{input} = \frac{1400}{700 + 600} = 1.08$$

$$Efficiency = \frac{output}{input} = \frac{1400}{700 + 500} = 1.17$$

Dilution of Maintenance

- Suppose 700 units of feed in a cow-calf system produce a weanling
- And 600 units of feed in the feedlot system finish it to 1,400 lb

$$Efficiency = \frac{output}{input} = \frac{1400}{700 + 600} = 1.08$$

- Now suppose the feedlot finishes to the heavier weight in less time
- And 500 units of feed in the feedlot system finish it to 1,400 lb

$$Efficiency = \frac{output}{input} = \frac{1400}{700 + 500} = 1.17$$

Dilution of Maintenance

- Can be obtained by finishing to heavier weights
- Can be obtained by faster growth rates
- Can be achieved by any technology that reduces cow-calf feed requirements
  - Cow size, replacement rate, reproductive success

Net Efficiency

- Net efficiency measures the amount of feed over and above maintenance required to produce a unit of weight gain
  - Maintenance requirement of an animal is the amount of feed required to sustain the animal with no net production
    - No weight gain or weight loss in a feedlot animal
  - Feed tables are based on average requirements for maintenance and average values for marginal efficiency
- There is individual animal variation in both maintenance requirements and net efficiency of gain
  - RFI and RADG result from differences in net efficiency and/or maintenance

Annual National Cost Savings

Value of a 2lb per day reduction in FI, no change in production

In Wt.	Out Wt.	Lb. Gain	ADG	Days on Feed	RFI	Reduced Feed Intake (lb)	Feed Cost Savings $/hd	% of Fed Mix	Total Feed Cost Savings
				Calf Feds					
600	1250	650	3.5	186	0.0	0			
600	1250	650	3.5	186	-2.0	-372	(54.72)	34	$ 502,620,656
				Yearling Feds					
775	1300	525	4.0	131	0.0	0			
775	1300	525	4.0	131	-2.0	-262	(38.67)	66	$ 689,539,820
								Total Savings:	**$ 1,192,160,476**

Annual fed slaughter cattle: 27 million head; Delivered feed cost: $ 294.62 as fed

Weaber

Greedy Improvement

- Adopt management and selection strategies IN ORDER TO reduce or dilute maintenance costs AND exploit improvements in net efficiency

Background

- Feed Intake (FI), required along with output production measures to characterize efficiency, is heritable but not cost-effective or practical for routine measurement across the national spectrum of seedstock and commercial cattle

Cattle Competing with Us

- Humans and livestock can compete for feed grains
- Most cows (ruminants) graze rangeland unsuitable for food crops
  - Grazing this land more than doubles the area used to produce food
- 25M feedlot animals are fed from land that could produce biofuel or human crops
  - Feedlot animals may be more carbon efficient
    - 140 d vs >365 d feeding dilutes maintenance
  - Genetic improvement would reduce competition with humans and reduce environmental impact per unit of produced beef

Long-term Goal

- *The long-term goal is to sustainably reduce feed resources required to produce beef via the rapid development and deployment of novel nutritional, genomic and genetic improvement technologies*
- *The team will strengthen the international competitiveness of US agriculture and enable increased food production via*
  - *diversion of animal to human food or energy crops*
  - *increasing production of animal protein without additional feed inputs*
  - *reducing the greenhouse gas footprint of beef production systems*

Research Objectives

- Assemble DNA samples, individual FI, growth and carcass composition data for 8,000 animals representing 8 major beef breeds

All investigators

Feed Intake Phenotypes

Breed	Year[1] 1	2	3	4	5	Total
Angus	698 (MU) 600 (UI)	200 (MU)		300 (MU)		1798
Red Angus	300 (UI)	300 (UI)				600
Simmental	1139 (UI)		300 (MU)			1439
Gelbvieh	300 (MU)	100 (MU)		50 (USMARC)	50 (USMARC)	500
Charolais	60 (WSU)	60 (WSU) 450 (UI)	60 (WSU) 450 (UI)	60 (WSU) 50 (USMARC)	60 (WSU) 50 (USMARC)	1300
Hereford	300 (AHA)	300 (AHA)	300 (AHA)	300 (AHA) 50 (USMARC)	300 (AHA) 50 (USMARC)	1600
Wagyu	70 (WSU)	70 (WSU)	70 (WSU)	70 (WSU)	70 (WSU)	350
Limousin	42 (ISU)	42 (ISU)	42 (ISU)	42 (ISU) 50 (USMARC)	42 (ISU) 50 (USMARC)	310
Total	3509	1522	1222	972	672	7897

Research Objectives

- Genotype 2,400 animals from 6 breeds with high-density 700k genotypes
  - Develop & validate across-breed genomic predictions
  - Another 1,400 animals already have 50k genotypes
    - Imputed up to 700k

GeneSeek, Taylor, Garrick

Research Objectives

- Sample superior and inferior animals for FE from groups of >300 Angus, Hereford, Gelbvieh or composite cattle to study:
  - Green-house gas emissions
  - Gut microbiome composition
  - Tissue-specific gene expression/gene networks (2 breeds)
    - Liver, small intestine, pituitary, hypothalamus, adipose 6 hi 6 lo

Freetly

Fahrenkrug, Neibergs, Seabury, Johnson, Beever

Research Objectives

- Use 180X bovine genome sequence representing >45M polymorphisms to fine-map QTL from whole genome analysis
  - Likely contain causal variants
  - Targeted 1,500 new SNPs genotyped in 2,000 animals

Seabury

Research Objectives

- Develop and maintain DNA, RNA and phenotype repositories for data obtained through project funding and provide public access to these samples

Taylor, Neibergs

Research Objectives

- Examine the roles of mitochondrial complex I and III proteins on FE of 600 animals from Angus, Simmental and Gelbvieh breeds
  - Goal to find a metabolic proxy for FI measurement

Kerley, Johnson

Research Objectives

- Perform grain x distillers, grain x forage and grow x finish feeding regimen interaction experiments on 900 Charolais steers & heifers with individual animal FI data
  - 400 of these will have 700k genotypes

Hansen, Shike, Faulkner

Research Objectives

- Provide research experiences for undergraduates at co-PD Universities to attract these to grad school and prepare the next generation of well-trained, diverse scientists with expert skills and breadth of knowledge to address sustainable beef production

All investigators

Extension Objectives

- Develop and deliver to a national industry-wide stakeholder audience the ***resources, tools, information and educational activities*** that will enhance their understanding of the:
  - importance of FE to farm economics and resource use
  - emerging technologies for genetic improvement in FE and component traits (FI, growth, carcass composition)
  - options to use marker assisted management (**MAM**) systems to sustainably improve profitability

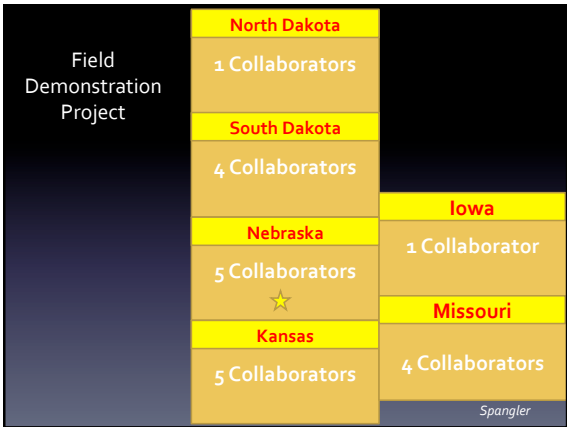
Loy, Spangler, Faulkner, Weaber

Extension Objectives

- Conduct a field demonstration project to demonstrate the utility of genomic EPDs for FE and component traits and "push" the technology into the beef industry

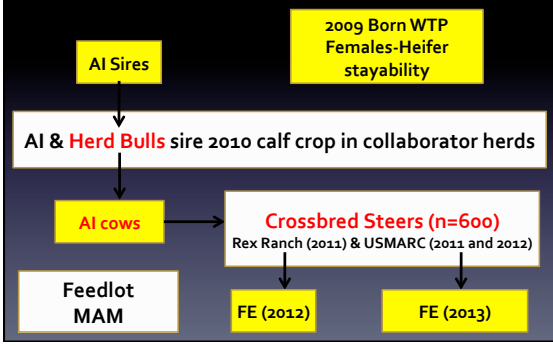
Spangler

Field Demonstration Project



Spangler

Field Demonstration (Weight Trait Project)



Field Demonstration

- Seedstock herds –50k genotypes on herd bulls
  - genomic EPD in Year 1 for WWD
    - Producers can directly measure target phenotype
  - Genomic EPD for FI/FE added in Year 3

Extension Objectives

- Deploy genomic selection based on genomic EPDs for FE and component traits to the international beef industry

Timelines

Activity Research → Extension →	Year 1	Year 2	Year 3	Year 4	Year 5
Cattle fed at MU					
Cattle fed at UI					
AHA, WSU, ISU cattle feeding/procurement					
Cattle fed at USMARC					
Research cattle genotyped					
Genotype imputation/MBV prediction equations					
RNA-Seq					
Network Analysis					
Fine mapping/causal mutation identification					
Ruminal/cecal methanogen bacterial abundance/CH_4					
Gastrointestinal tract metagenome					
Repositiories					
Efficiency/performance/digestion/GHG emssions					
Nutritional environment interactions					
Undergraduate research experience					
Extension cattle genotyped					
Genotype imputation/Analysis					
Website					
Broadcast					
Educational Conference					
Youth Conference					
Educational Materials					
Decision Support Software					
Field Demonstration – Breeder Component					
Field Demonstration – Feedlot Component					
Evaluation					

Summary

- This multi-institutional 5-Year national project will
  - Undertake basic and applied research related to identifying factors that improve feed efficiency
  - Extend its findings to stakeholders using a variety of communication approaches
  - Implement its discoveries within the context of the beef industry infrastructure

www.BeefEfficiency.org

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USDA United States Department of Agriculture | National Institute of Food and Agriculture